Title of Investigation:

Scalable Hybrid Airship Platform for Exploration and Science (SHAPES)

Principal Investigator:

David Wilcox (Code 548) and Co-Investigator Geoff Bland (Code 972)

Other In-House Members of the Team:

Ted Miles (Code 569), Victor Eyo (Code 548), and Bob Ray (Code 548)

Initiation Year:

FY 2004

Aggregate Amount of Funding:

$40,000, 0.7 FTE

Funding Authorized for FY 2005:

$0, 0.2 FTE labor

Actual Expenditure of FY 2005 Funding:

$19,000 of FY 2004 funding spent in FY 2004; remainder of FY 2004 funding ($21,000) spent in FY 2005

Status of Investigation at End of FY 2005:

Terminated in FY 2005 (reduction of requested FTEs resulted in inability to complete planned work; revised work plan and spent remaining funds to allow continued low-level research)

Expected Completion Date:

Ongoing R&D

Purpose of Investigation:

Scalable Hybrid Airship Platform for Exploration and Science (SHAPES) is the initial pathfinder platform for flying lightweight miniaturized Earth science payloads on a low-speed, low-altitude unmanned aerial vehicle, specifically a hybrid airship. Remote sensing has numerous applications for such a capability and is an essential component of coastal-zone research. In addition, initial studies have suggested that the hybrid-airship design may be the optimum vehicle for planetary missions.

A hybrid airship uses a combination of static lift from an airship-like envelope and dynamic lift from an aircraft-like wing. The craft would be somewhat negatively buoyant, reducing the need for large ground-handling crews and alleviating the hazards associated with the loss of powered flight or control. These represent advantages over the traditional blimp.

This project provides key information on the vehicle's performance and optimal design features. The primary goal of SHAPES is to answer the hard questions associated with developing an alternative technology platform, including launch and recovery, stability (both sensor environment and performance), and control.

The baseline prototype design has a target scientific payload of 2.5 kg (5.5 lb). The craft would measure 8.2 m(27 ft.) in length, 1.5 meters (5 ft) in diameter, with a wingspan of 6.1 m (20 ft). The initial prototype vehicle would use electric propulsion, battery power, and a R/C control system.

SHAPES addresses an area of platform research currently not being explored for Earth science. While UAV platforms are becoming increasingly more important to both NASA and the U.S. Department of Defense, the hybrid airship concept remains a largely unexplored configuration. Previous ventures involving hybrid airships, primarily based in Europe, have focused on high-altitude heavy-lift applications. A low-cost development effort will not only provide immediate access for miniaturized Earth Science sensors and instrumentation, but also will serve as a proving ground for larger coastal-zone applications and even planetary operational concepts.

Accomplishments to Date:

FY 2004: Procurements that totaled about $19,000 were completed in FY 2004 for most of the prototype's subsystems, including the propulsion elements, lithium-polymer batteries, control-system hardware, lifting envelopes, carbon sensor and data-logger hardware, and structural materials. Fabrication of an extremely stiff, but lightweight main truss structure was completed in FY 2004. Initial designs were developed for other critical structural subsystems and their interfaces.

FY 2005: Due to the limited FTEs available in FY 2005, the projected work was not completed on the baseline prototype. Therefore, funds set aside for the purchase of science instrumentation and Wallops Flight Facility range costs were diverted to other areas that would promote continued research and development of novel hybrid inflatable structures. This included the purchase of components and support equipment for rudimentary small-scale prototypes to investigate the balance between buoyant and aerodynamic lift. In addition, funds were used to obtain engineering tools, such as photogrammetry equipment for measuring strain in inflatable structures and Computational Fluid Dynamics (CFD) analysis software to estimate lift and drag characteristics of lifting body shapes.

Planned Future Work:

Using resources obtained with FY 2005 funds and the support of a Code 548 “corporate hire” engineer, we will continue low-level basic research into lifting body shapes and the appropriate buoyant-to-aerodynamic lift ratio.

Key Points Summary:

The innovative elements in this proposal include assessing, via real prototyping, the aerodynamics of hybrid-lift vehicles. Little work has been done on hybrid platforms of this type. SHAPES also is unique in that it has almost direct application to planetary-exploration tasks. The “payoff” to NASA, and specifically Goddard, is that this initial work could position us to be competitive in future exploration proposals that we have not previously been seen as relevant.

Unfortunately, efforts in FY 2004 and FY 2005 were severely hampered by reductions in project FTEs, either by adjustment of awarded FTEs or by reassignment of key personnel to other more adequately funded projects. It is hoped that enough low-level research can continue so that a follow-on proposal can be developed with a more defined exploration-related goal, allowing the SHAPES concept to reach its full potential.